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(71) Applicant: KIMBERLY-CLARK WORLDWIDE, INC. [US/US]; 401 N. Lake Street, Neenah, WI 54956 (US).

(72) Inventors: FENWICK, Christopher, Dale; 910 Ramsden Run, Alpharetta, GA 30022 (US). HAYNES, Bryan, David; 7125 Fox Chase Way, Cumming, GA 30040 (US). BROWN, Kurtis, Lee; 700 Rhodes Creek Trail, Alpharetta, GA 30004 (US). PAUL, Susan, Carol; 310 Tanners Crossing, Alpharetta, GA 30022 (US). TRUSOCK, Christian, Michael; 7270 Treyburn Drive, Alpharetta, GA 30041 (US). LAMBIDONIS, Melpo; 3730 Warrington Drive, Cumming, GA 30040 (US). BARATIAN, Stephen, Avedis; 6520 Roswell Road, #53, Atlanta, GA 30328 (US).

(74) Agents: KYRIAKOU, Christos, S. et al.; KIMBERLY-CLARK WORLDWIDE, INC., 401 N. Lake St., Neenah, WI 54956 (US).

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(54) Title: NONWOVEN MATERIALS HAVING SURFACE FEATURES

(57) Abstract: A three-dimensional nonwoven web having a regional, bulk density of less than 0.04 grams per cubic centimeter, a top-side base surface that defines an x,y-plane and at least one macroscopic surface feature extending out of the x,y-plane wherein a macroscopic surface feature is characterized as a feature having an apex that extends at least about 1 millimeter above the x,y-plane of the top-side base surface is provided. The macroscopic feature maintains a height of at least 1 millimeter above the x,y-plane of the top-side base surface under a 1.2 kPa load (Pf) and results in contact of an object resting on the macroscopic feature such that the percent contact area of the nonwoven web with an article resting on the macroscopic surface feature at a 1.2 kPa load (Pf) is less than 50 percent of the bulk area of the nonwoven web supporting the article.

NONWOVEN MATERIALS HAVING SURFACE FEATURES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is related to commonly assigned U.S. Patent Application Serial No. 10/136,702, entitled "METHODS FOR MAKING NONWOVEN MATERIALS ON A SURFACE HAVING SURFACE FEATURES AND NONWOVEN MATERIALS HAVING SURFACE FEATURES" filed by Express Mail Procedure **EL471213680 US** contemporaneously herewith and which is hereby incorporated by reference herein.

FIELD

The present invention is directed to nonwoven materials having surface features.

BACKGROUND

Nonwoven fabrics are useful for a wide variety of applications, including absorbent personal care products, garments, medical products, and cleaning products. Nonwoven personal care products include infant care items such as diapers, child care items such as training pants, feminine care items such as sanitary napkins, and adult care items such as incontinence products. Nonwoven garments include protective workwear and medical apparel such as surgical gowns. Other nonwoven medical products include nonwoven wound dressings and surgical dressings. Cleaning products that contain nonwovens include towels and wipes. Still other uses of nonwoven fabrics are well known. The foregoing list is not considered exhaustive.

Various properties of nonwoven fabrics determine the suitability of nonwoven fabrics for different applications. Nonwoven fabrics may be engineered to have different combinations of properties to suit different needs. Variable properties of nonwoven fabrics include liquid-handling properties such as wettability, distribution, and absorbency, strength properties such as tensile strength and tear strength, softness properties, durability properties such as abrasion resistance, and aesthetic properties. The physical shape of a nonwoven fabric also affects the functionality and aesthetic properties of the nonwoven fabric. Nonwoven fabrics are initially made into sheets which, when laid on a flat surface, may have a substantially planar, featureless surface or may have an array of surface features such as apertures or projections, or both. Nonwoven fabrics with apertures or projections are often referred to as three-dimensional or shaped nonwoven

fabrics. The present invention relates to three-dimensional or shaped nonwoven fabrics.

The manufacture of nonwoven fabrics is a highly developed art. Generally, nonwoven webs and their manufacture involve forming filaments or fibers and depositing the filaments or fibers on a carrier in such a manner so as to cause the filaments or fibers to overlap or entangle. Depending on the degree of web integrity desired, the filaments or fibers of the web may then be bonded by means such as an adhesive, the application of heat or pressure, or both, sonic bonding techniques, or entangling by needles or water jets, and so forth. There are several methods of producing fibers or filaments within this general description; however, two commonly used processes are known as spunbonding and meltblowing and the resulting nonwoven fabrics are known as spunbond and meltblown fabrics, respectively.

Generally described, the process for making spunbond nonwoven fabrics includes extruding thermoplastic material through a spinneret, quenching and drawing the extruded material into filaments with a stream of high-velocity air to form a random web on a forming surface. Such a method is referred to as meltspinning. Spunbond processes are generally defined in numerous patents including, for example, U.S. Patent No. 3,802,817 to Matsuki et al.; U.S. Patent No. 4,692,618 to Dorschner, et al.; U.S. Patent No. 4,340,563 to Appel, et al.; U.S. Patent Nos. 3,338,992 and 3,341,394 to Kinney; U.S. Patent No. 3,502,538 to Levy; U.S. Patent Nos. 3,502,763 and 3,909,009 to Hartmann; U.S. Patent no. 3,542,615 to Dobo, et al.; and Canadian Patent No. 803,714 to Harmon.

On the other hand, meltblown nonwoven fabrics are made by extruding a thermoplastic material through one or more dies, blowing a high-velocity stream of air, usually heated air, past the extrusion dies to generate an air-conveyed meltblown fiber curtain and depositing the curtain of fibers onto a forming surface to form a random nonwoven web. Meltblowing processes are generally described in numerous publications including, for example, an article titled "Superfine Thermoplastic Fibers" by Wendt in Industrial and Engineering Chemistry, Vol. 48, No. 8, (1956), at pp. 1342-1346, which describes work done at the Naval Research Laboratory in Washington, D.C.; Naval Research Laboratory Report 111437, dated April 15, 1954; U.S. Patent nos. 4,041,203, 3,715,251, 3,704,198, 3,676,242 and 3,595,245; and British Specification 1,217,892.

Spunbond and meltblown nonwoven fabrics can usually be distinguished by the diameters and the molecular orientation of the filaments or fibers that form the fabrics. The diameter of spunbond and meltblown filaments or fibers is the average cross-sectional dimension. Spunbond filaments or fibers typically have average diameters greater than 6 microns and often have average diameters in the range of 12 to 40 microns. Meltblown fibers typically have average diameters of less than 6 microns.

However, because larger meltblown fibers, having diameters of at least 6 microns may also be produced, molecular orientation can be used to distinguish spunbond and meltblown filaments and fibers of similar diameters. For a given fiber or filament size and polymer, the molecular orientation of a spunbond fiber or filament is typically greater than the molecular orientation of a meltblown fiber. Relative molecular orientation of polymeric fibers or filament can be determined by measuring the tensile strength and birefringence of fibers or filaments having the same diameter.

Tensile strength of fibers and filaments is a measure of the stress required to stretch the fiber or filament until the fiber or filament breaks. Birefringence numbers are calculated according to the method described in the spring 1991 issue of <u>INDA Journal of Nonwovens Research</u>, (Vol. 3, No. 2, p. 27). The tensile strength and birefringence numbers of polymeric fibers and filaments vary depending on the particular polymer and other factors; however, for a given fiber or filament size and polymer, the tensile strength of a spunbond fiber or filament is typically greater than the tensile strength of a meltblown fiber and the birefringence number of a spunbond fiber or filament is typically greater than the birefringence number of a meltblown fiber.

A number of patents describe methods for making shaped or three-dimensional nonwoven fabrics: for example, U.S. Patent Nos. 5,575,874 and 5,643,653 issued to Griesbach et al.; U.S. Patent No. 4,741,941 issued to Engelbert et al.; and U.S. Patent Nos. 6,331,268, 6,331,345 and 6,455,319 issued to Kauschke et al. Despite prior advances in the art, there is still a need for improved nonwoven fabrics having surface features and methods for forming such nonwoven fabrics.

To avoid confusion it is important to clarify the terminology used throughout the body of the application in describing pressures and loads. The practices used for determining these values are detailed in the methods section. For the purposes of describing the resiliency of surface features, the average pressure exerted on a surface feature is denoted P_f. For the purposes of material characterization of the web and techniques used for bulk compressometry a different pressure is reported. This is the pressure exerted on the web or P_w. P_w is the pressure that would be exerted on a flat material having 100 percent contact with the load or force.

SUMMARY

In response to the difficulties and problems encountered in the prior art, new nonwoven materials have been discovered. In accordance with the present invention nonwoven fabrics having one or more macroscopic surface features are described.

The present invention provides a three-dimensional nonwoven web having a regional, bulk density of less than 0.04 grams per cubic centimeter wherein the nonwoven web includes a top-side base surface that defines an x,y-plane and at least one macroscopic surface feature extending out of the x,y-plane wherein a macroscopic surface feature is characterized as a feature having an apex that extends at least about 1 millimeters above the x,y-plane of the top-side base surface and the maintains a height of at least 1 millimeter above the x,y-plane of the top-side base surface under a 1.2 kPa load (P_f) and wherein the macroscopic feature minimizes contact of an object resting on the macroscopic feature such that the area of contact of the nonwoven web with an article resting on the macroscopic surface feature at a 1.2 kPa load (P_f) of article to contact area of nonwoven web is less than 50 percent of the bulk area of the nonwoven web supporting the article.

In one embodiment, a macroscopic feature is characterized as a feature having an apex that extends at least 1.5 millimeters above the x,y-plane. In another embodiment, a macroscopic feature is characterized as a feature having an apex that extends at least 3 millimeters above the x,y-plane. In yet another embodiment, a macroscopic feature is characterized as a feature having an apex that extends at least 5 millimeters above the x,y-plane. In still yet another embodiment, a macroscopic feature is characterized as a feature having an apex that extends at least about 6 millimeters above the x,y-plane.

The area of contact of the nonwoven web with an article resting on the macroscopic surface feature at a 1.2 kPa load (P_f) of article to contact area of nonwoven web may be less than 40, 30 and even less than 25 percent of the bulk area of the nonwoven web supporting the article. The nonwoven may include a plurality of macroscopic features and the frequency of macroscopic features is at least 1 macroscopic surface feature per 100, 50, 10 and even 1 square centimeter of nonwoven web in the x,y-plane. The regional bulk density of the nonwoven web may be less than 0.03 and even less than 0.02 grams per cubic centimeter.

In one particular embodiment, the macroscopic features maintain a height of at least 1.5 millimeters above the x,y-plane of the top-side base surface under a 1.2 kPa load (P_f). In other embodiments, the macroscopic features maintain a height of at least 3 and even 6 millimeters above the x,y-plane of the top-side base surface under a 1.2 kPa load (P_f). In another particular embodiment, the macroscopic feature maintains a height of at least 1 millimeter above the x,y-plane of the top-side base surface under a 1.8 kPa load (P_f). In other embodiments, the macroscopic feature maintains a height of at least 1.5, 3 and even 6 millimeters above the x,y-plane of the top-side base surface under a 1.8 kPa load (P_f). In yet another particular embodiment, the macroscopic feature maintains a height of

at least 1 millimeter above the x,y-plane of the top-side base surface under a 10 kPa load. In other embodiments, the macroscopic feature maintains a height of at least 1.5,3 and even 6 millimeters above the x,y-plane of the top-side base surface under a 10 kPa load.

The nonwoven webs of the present invention may include macroscopic features that provide at least 0.08 cubic centimeters of air space, 0.09 cubic centimeters of air space and even greater than 0.10 cubic centimeters of air space per square centimeter between the top surface of the nonwoven web and an article resting on the macroscopic surface feature at a 0.3450 kPa load on the web (P_w). In several of the embodiments, the nonwoven web has a uniform composition in the x and y directions. In several of the embodiments, the nonwoven web is a laminate. The nonwoven web may be made from bicomponent fibers.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1A is a perspective view of a nonwoven web of the present invention.

Figure 1B is a cross-sectional view of the nonwoven web illustrated in Figure 1A.

Figure 1C is a top-side plan view of the nonwoven web illustrated in Figure 1A.

Figure 2A is a perspective view of a substantially planar article supported on the nonwoven web of Figures 1A, 1B and 1C.

Figure 2B is a cross-sectional view of a substantially planar article supported on the nonwoven web of Figures 1A, 1B and 1C.

Figure 2C is a top-side plan view of a substantially planar article supported on the nonwoven web of Figures 1A, 1B and 1C.

Figure 3A is a perspective view of an embossing plate.

Figure 3B is a perspective view of an opposing embossing plate.

Figure 3C is a cross-sectional view of the embossing plates of Figures 3A and 3B forming a nonwoven web of the present invention.

Figure 4A is a perspective view of another embossing plate.

Figure 4B is a perspective view of another opposing embossing plate.

Figure 5A is a perspective view of another nonwoven web of the present invention.

Figure 5B is a cross-sectional view of the nonwoven web illustrated in Figure 5A.

Figure 5C is a top-side plan view of the nonwoven web illustrated in Figure 5A.

Figure 6 is a cutaway view of an absorbent article incorporating a nonwoven fabric of the invention.

Figure 7 is a partial cross-sectional view of the absorbent article of Figure 6.

Figure 8 is a perspective view of yet another nonwoven web of the present invention.

DEFINITIONS

As used herein the following terms have the specified meanings, unless the context demands a different meaning, or a different meaning is expressed; also, the singular generally includes the plural, and the plural generally includes the singular unless otherwise indicated.

Words of degree, such as "**about**", "**substantially**", and the like are used herein in the sense of "at, or nearly at, when given the manufacturing and material tolerances inherent in the stated circumstances" and are used to prevent the unscrupulous infringer from unfairly taking advantage of the invention disclosure where exact or absolute figures are stated as an aid to understanding the invention.

As used herein, the term **"absorbent product"** or **"personal care absorbent product"** means diapers, training pants, swim wear, absorbent underpants, adult incontinence products, sanitary wipes, wipes, feminine hygiene products, wound dressings, nursing pads, time release patches, bandages, mortuary products, veterinary products, hygiene and so forth.

As used herein, the term "**airlaid web**" refers to nonwoven webs made by "airlaying". Airlaying is a well-known process by which a fibrous nonwoven layer can be formed. In the airlaying process, bundles of small fibers having typical lengths ranging from about 3 to about 52 millimeters (mm) are separated and entrained in an air supply and then deposited onto a forming screen, usually with the assistance of a vacuum supply. The randomly deposited fibers then are bonded to one another using, for example, hot air or a spray adhesive. Airlaying is taught in, for example, US Patent 4,640,810 to Laursen et al.

As used herein, the term "**apex**" refers to the highest or furthest portion of a feature and is meant to include points as well as planes and other surfaces that are not sharp ends.

As used herein, the term "**bonded carded web**" refers to webs that are made from staple fibers which are sent through a combing or carding unit, which separates or breaks apart and aligns the staple fibers in the machine direction to form a generally machine direction-oriented fibrous nonwoven web. This material may be bonded together by methods that include point bonding, through air bonding, ultrasonic bonding, adhesive bonding, etc.

As used herein, the terms **"comprises"**, **"comprising"** and other derivatives from the root term "comprise" are intended to be open-ended terms that specify the presence of any stated features, elements, integers, steps, or components, but do not preclude the presence or addition of one or more other features, elements, integers, steps, components, or groups thereof.

As used herein, the term "**fabric**" refers to all of the woven, knitted and nonwoven fibrous webs.

As used herein, the term "**hydrophilic**" describes fibers, materials or the surfaces of fibers materials that are wetted by the aqueous liquids in contact with the fibers or other materials. The degree of wetting of the materials can, in turn, be described in terms of the contact angles and the surface tensions of the liquids and materials involved. Equipment and techniques suitable for measuring the wettability of particular fiber materials can be provided by a Cahn SFA-222 Surface Force Analyzer System, or a substantially equivalent system. When measured with this system, fibers having contact angles less than 90° are designated "wettable" or hydrophilic, while fibers having contact angles equal to or greater than to 90° are designated "nonwettable" or hydrophobic.

As used herein, the term **"macroscopic surface features"** describes three-dimensional features that extend from the surface and are large enough to be perceived or examined with the unaided eye, desirably such features have at least one dimension that is greater than 3/32 of an inch (~1 mm), more desirably such features have at least one dimension that is greater than one sixteenth of an inch (~1.5 mm), still more desirably such features have at least one dimension greater than one eighth of an inch (~3 mm) and even more desirably such features have at least one dimension greater than one quarter of an inch (~6 mm).

As used herein the term **"meltblown fibers"** means fibers formed by extruding a molten thermoplastic material through a plurality of fine, usually circular, die capillaries as molten threads or filaments into converging high velocity, usually hot, gas (e.g. air) streams which attenuate the filaments of molten thermoplastic material to reduce their diameter, which may be to microfiber diameter. Thereafter, the meltblown fibers are carried by the high velocity gas stream and are deposited on a forming surface to form a web of randomly dispersed meltblown fibers. Such a process is disclosed, for example, in US Patent 3,849,241 to Butin et al. Meltblown fibers are microfibers, which may be continuous or discontinuous, are generally smaller than 10 microns in average diameter, and are generally tacky when deposited onto a forming surface.

As used herein **"multilayer laminate"** means a laminate including two or more layers of material laminated into a finished structure. For example, one or more of the

layers may be a spunbond layer and/or some of the layers may be a meltblown layer. One specific example of a multilayer laminate is a spunbond/meltblown/spunbond (SMS) laminate. Other multilayer laminates are disclosed in U.S. Patent no. 4,041,203 to Brock et al., U.S. Patent no. 5,169,706 to Collier, et al, U.S. Patent no. 5,145,727 to Potts et al., U.S. Patent no. 5,178,931 to Perkins et al. and U.S. Patent no. 5,188,885 to Timmons et al. A multilayer laminate may be made by sequentially depositing onto a moving forming belt first a spunbond fabric layer, then a meltblown fabric layer and last another spunbond layer and then bonding the laminate in a manner described below. Alternatively, the fabric layers may be made individually, collected in rolls, and combined in a separate bonding step. Such fabrics usually have a basis weight of from about 0.1 to 12 ounces per square yard (osy) [3 to 400 grams per square meter (gsm)], or more particularly from about 0.75 osy to about 3 osy (25-102 grams per square meter). Multi-layer laminates may also have various numbers of meltblown layers or multiple spunbond layers in many different configurations and may include other materials like films (F) or coform materials, e.g. SMMS, SM, SFS, and so forth.

As used herein the terms **"nonwoven"** and **"nonwoven fabric or web"** mean a web having a structure of individual fibers, filaments or threads which are interlaid, but not in an identifiable manner as in a knitted fabric. Nonwoven fabrics or webs have been formed from many processes such as for example, meltblowing processes, spunbonding processes, and bonded carded web processes. The basis weight of nonwoven fabrics is usually expressed in ounces of material per square yard (osy) or grams per square meter (gsm) and the fiber diameters useful are usually expressed in microns. (Note that to convert from osy to gsm, multiply osy by 33.91).

As used herein, the term **"solid"** does not completely exclude the presence of voids or cavities in the interior of the projections. On the contrary, as will be apparent to those skilled in the art, the forming the projections may well leave voids or cavities in the projections due to variabilities in processing. The term "solid" as used herein, therefore, means that the interior of a given projection is not substantially free from fibers or filaments or other solid when compared with the base material.

As used herein the term **"spunbonded webs"** refers to webs comprising small diameter fibers which are formed by extruding molten thermoplastic material as filaments from a plurality of fine, usually circular capillaries of a spinneret with the diameter of the extruded filaments then being rapidly reduced as by, for example, in U.S. Patent no. 4,340,563 to Appel et al., and U.S. Patent no. 3,692,618 to Dorschner et al., U.S. Patent no. 3,802,817 to Matsuki et al., U.S. Patent nos. 3,338,992 and 3,341,394 to Kinney, U.S. Patent no. 3,502,763 to Hartman, and U.S. Patent no. 3,542,615 to Dobo et al. Spunbond

fibers are generally not tacky when they are deposited onto a forming surface. Spunbond fibers are generally continuous and have average diameters (from a sample of at least 10) larger than 7 microns, more often, between about 10 and 20 microns.

These terms may be defined with additional language in the remaining portions of the specification.

DETAILED DESCRIPTION

As discussed above, the present invention provides three-dimensional nonwoven fabrics having one or more macroscopic surface features. It is desirable that the surface features are macroscopic in size and provide separation between the majority of the nonwoven fabric surface and a body part that is in contact with the nonwoven fabric. Such a nonwoven fabric is particularly useful as a body side liner in a personal care article, such as a diaper, pantiliner and so forth. Nonwoven fabrics of the present invention may further include apertures and non-macroscopic projections as well as the macroscopic features. Nonwoven fabrics of the present invention are also useful for making garments, medical products, cleaning products, packaging materials, construction materials such as sound proofing and insulation, and so forth.

Exemplary nonwoven webs of the present invention are illustrated in Figures 1A, 1B and 1C; Figures 5A, 5B and 5C; and Figure 8. The present invention will be described with reference to the exemplary nonwoven web illustrated in Figures 1A, 1B and 1C. The nonwoven web is a three-dimensional nonwoven web **100** that includes a top-side base surface **104** that defines an x,y-plane and at least one macroscopic surface feature **120** extending out of the x,y-plane wherein a macroscopic surface feature **120** is characterized as a feature having an apex **106** that extends at least about 1 millimeter above the x,y-plane of the top-side base surface **106**. The nonwoven web illustrated in Figures 1A, 1B and 1C and described in greater detail in Example 1 includes macroscopic features having apexes **106** that extend at least about 2 millimeters above the x,y-plane of the top-side base surface **106**. The nonwoven web illustrated in Figures 5A, 5B and 5C and described in greater detail in Example 5 includes macroscopic features having apexes **106** that extend at least about 3 millimeters above the x,y-plane of the top-side base surface **106**. In certain embodiments, the macroscopic features have an apex that extends at least about 1, 1.5, 3, 5 or even about 6 millimeters above the x,y-plane. It is desirable that the macroscopic features **120** have increased height to provide increased separation. Increased height of the macroscopic features increases the bulk thickness T of the web and thus decreases the bulk density of the nonwoven web. For example, the

regional bulk density of a nonwoven web of the present invention may be less than 0.04 grams per cubic centimeter, less than 0.03 grams per cubic centimeter or even less than 0.02 grams per cubic centimeter.

It is also desirable that the macroscopic features **120** maintain a height of at least 1 millimeter above the x,y-plane of the top-side base surface **104** under a particular load, for example under a 1.2 kPa load (P_f), to minimize contact when pressure is applied to the nonwoven web **100**. In certain embodiments, the macroscopic features maintain a height **h** of at least about 1, 1.5, 3, 5 or even 6 millimeters above the x,y-plane of the top-side base surface **104** under load. A substantially planar article resting on the nonwoven web of Figures 1A, 1B and 1C is illustrated in Figures 2A, 2B and 2C to demonstrate some of the features of the nonwoven webs of the present invention. The contact area of an object P with a nonwoven sheet **100** is the sum of the area(s) **106** of the nonwoven sheet that directly contact the object P resting on the nonwoven sheet, more particularly the macroscopic features **120**. For example, the contact area of an object P supported by surface features **120** of a nonwoven **100** is the sum of the areas of all of the features and any other parts of the nonwoven web, if any, that directly contact the object P resting on the features **120**. In Figure 2A, the contact area of object P with the nonwoven **100** is the sum of the cross-hatched areas shown in Figures 2A and 2C. The percent contact area that an object P has with a nonwoven web supporting P with features **120**, is measured by dividing the contact area described above by the flat contiguous area that connects all of the points of the sheet that directly contact the article. For example, if an object is supported by sixteen macroscopic features **100**, then the area of the nonwoven web that includes the features supporting the object P is the contiguous "bulk area" ($L_p \times W_p$) measured in a plane parallel to the nonwoven base plane that connects all of the sixteen features or the parts of the sixteen features that support the object. Therefore the percent contact area would be the contact area divided by the bulk area ($L_p \times W_p$). In Figure 2C, the pressure that an object P supported by the nonwoven transmits to the sheet P_w is measured by dividing the weight of the supported object P by the flat contiguous area ($L_p \times W_p$) beneath the object. The average pressure observed by the surface feature P_f is determined by correcting for the actual area in contact with the load. The average pressure observed by the surface feature P_f can be determined by dividing P_w by the percent contact area.

Desirably, the macroscopic feature(s) **120** minimize contact of an object resting on the feature(s) such that the area of contact of the nonwoven web with an article resting on the macroscopic surface feature at given load is less than 50 percent of the bulk area of

the nonwoven web ($L_p \times W_p$) supporting the article. More desirably, the area of contact of the nonwoven web with an article resting on the macroscopic surface feature at a given load of article to contact area of nonwoven web may be less than 40, 30 and even less than 25 percent of the bulk area of the nonwoven web supporting the article. Thus, it is desirable that the nonwoven web and the macroscopic features of the nonwoven web do not compress completely under a given load so that the features minimize contact area and provide separation under a given load. It is also desirable that the features are resilient and return to some measurable height h, desirably greater than 1mm, after a 3.45 kPa load is applied to the web so that the features provide separation after a 3.45 kPa is applied to the web and is then removed.

The nonwoven may include a plurality of macroscopic features to provide separation over a larger area or to provide increased support. The frequency of macroscopic features may vary greatly. For example, it is envisioned that nonwoven webs of the present invention may include as few as 1 macroscopic surface feature per 1, 10, 50 or even 100 square centimeters of nonwoven web in the in the x,y-plane. It is desirable to decrease the number of macroscopic features per unit area of web to decrease contact area. The frequency of the macroscopic features in Examples 1-3 below was about 2 features per square centimeter and about 1 feature per square centimeter in Examples 4 and 5. The frequency of the macroscopic feature illustrated in Figure 8 may be one feature per 500 square centimeters.

As illustrated in Figure 8, it is not necessary to provide macroscopic features **120** over the entire surface **104** of the web **100**. For example, one or more macroscopic feature may be provided in a particular location, for example the target zone of a diaper liner, to provide separation in that location as illustrated in Figure 8. Figure 8 illustrates a nonwoven web **100** that includes only one macroscopic surface feature **120** measuring about 10 centimeters by 10 centimeters along the exterior widths and an interior opening dimension of about 9 centimeters by 9 centimeters. The macroscopic feature **120** has a height of about 4 millimeters. The single macroscopic features **120** desirably should be located in the target zone of a diaper liner to provide separation between a baby's bottom and the diaper liner surface and any absorbent material located beneath the liner in the target zone.

In one particular embodiment, the macroscopic features maintain a height of at least 1 millimeter above the x,y-plane of the top-side base surface under a 1.2 kPa load (P_f). In another embodiment, the macroscopic features maintain a height of at least 1.5 millimeters above the x,y-plane of the top-side base surface under a 1.2 kPa load (P_f). In

yet other embodiments, the macroscopic features maintain a height of at least 3, 5 and even 6 millimeters above the x,y-plane of the top-side base surface under a 1.2 kPa load (P_f). In another particular embodiment, the macroscopic feature maintains a height of at least 1 millimeter above the x,y-plane of the top-side base surface under a 1.8 kPa load (P_f). In other embodiments, the macroscopic feature maintains a height of at least 1.5, 3 and even 6 millimeters above the x,y-plane of the top-side base surface under a 1.8 kPa load (P_f). In yet another particular embodiment, the macroscopic feature maintains a height of at least 1 millimeter above the x,y-plane of the top-side base surface under a 10 kPa load. In other embodiments, the macroscopic feature maintains a height of at least 1.5,3 and even 6 millimeters above the x,y-plane of the top-side base surface under a 10 kPa load. The nonwoven webs of the present invention may include macroscopic features that provide at least 0.08, 0.09 and even greater than 0.10 cubic centimeters per square centimeter of air space between the top surface of the nonwoven web and an article resting on the macroscopic surface feature at a 0.3450 kPa load on the web (P_w).

In the exemplary embodiments, the nonwoven web is illustrated as a single layer web that has a uniform composition in the x, y and z directions. However, nonwoven webs of the present invention may be laminates having a uniform composition in the in both the x and the y directions. In the exemplary embodiments, the nonwoven webs of the present invention are also bicomponent spunbond nonwoven webs. However, nonwoven webs of the present invention can be made by methods other than spunbond methods and may include single component and/or multicomponent fibers, filaments and layers.

Spunbond nonwoven webs are formed by depositing melt spun, continuous multicomponent polymeric fibers onto a forming surface. Bicomponent fibers and melt spinning are known and are described in U.S. Patent Nos. 5,575,874 and 5,643,653 issued to Griesbach et al. which are herein incorporated by reference in their entirety. Multicomponent meltspun nonwoven fabrics and methods of making multicomponent meltspun nonwoven fabrics are also known and are described in U.S. Patent No. 5,382,400 issued to Pike et al. which is also herein incorporated by reference in its entirety. Methods for extruding multicomponent polymeric filaments are also known. Suitable materials for preparing the bicomponent filaments of the nonwoven fabrics of the present invention include PD-3155 polypropylene available from Exxon Mobil of Houston, Texas; a linear low density polyethylene (LLDPE) available under the designation ASPUN 6811A, 2553 LLDPE and 61800 polyethylene available from Dow Chemical Company of Midland, Michigan; and 25355 and 12350 HDPEs available from Dow Chemical Company. When a polypropylene is component A and a polyethylene is component B, the

bicomponent filaments may comprise from about 20 to about 80 percent by weight of a polypropylene and from about 80 to about 20 percent polyethylene. More desirably, the filaments may comprise from about 40 to about 60 percent by weight polypropylene and from about 60 to about 40 percent by weight polyethylene.

It is desirable that the filaments of the nonwoven web are crimped to provide a lofty nonwoven. Although the illustrated method of carrying out the present invention includes multicomponent filaments that are crimped, the present invention encompasses uncrimped fibers as well as fibers that are crimped by other methods, for example mechanically crimping fibers. Crimped fibers and methods of crimping fibers are known in the art. The present invention also contemplates use of nonwoven webs made by other methods for example, bonded carded webs, meltblown webs and webs made from uncrimped filaments and/or single component filaments. When the spunbond filaments are crimped, the fabric of the present invention advantageously results in a relatively high loft material that is also relatively resilient. The crimp of the filaments creates an open web structure with substantial void portions between filaments and the filaments are bonded at points of contact of the filaments. Again, although the nonwoven fabric described above is made with spunbond bicomponent filaments, it should be understood that nonwoven fabrics of the present invention may be made with single component spunbond filaments, meltblown filaments, bonded carded webs, air laid webs and so forth. For example, single component spunbond filaments can be made in the same manner as described in the Examples except that the spinneret will be adapted to make single component filaments. See, for example, the patents previously identified with respect to spunbond processes. Furthermore, the fibers may be bonded by adding an adhesive polymeric component in another manner.

A spunbond/meltblown/spunbond (SMS) laminate nonwoven fabric can be made to include macroscopic surface features. Meltblown processes of making nonwoven fabrics and SMS nonwoven fabrics are known. Suitable meltblowing techniques and SMS fabrics are disclosed in U.S. Patent Number 4,041,203, the disclosure of which is incorporated herein by reference. U.S. Patent 4,041,203 references the following publications on meltblowing techniques which are also incorporated herein by reference: an article entitled "Superfine Thermoplastic Fibers" appearing in Industrial Engineering Chemistry, Volume 48, Number 8, ppgs. 1342-1346 which describes work done at the U.S. Naval Research Laboratories in Washington, D.C.; Naval Research Laboratory Report 111437, dated April 15, 1954; U.S. Patent Nos. 3,715,251; 3,704,198; 3,676,242; and 3,595,245; and British Specification No. 1,217,892.

Spunbond meltblown integrated composite (SMIC) materials are described and illustrated in the previously mentioned U.S. Patent Nos. 5,575,874 and 5,643,653 issued to Griesbach et al. Generally, an SMIC material can be produced by meltblowing material on each side of a spunbond filament curtain. Meltblowing dies can be positioned on each side of the spunbond filament curtain in a symmetric fashion to produce a SMIC fabric. The process is described in more detail in U.S. Patent Nos. 5,575,874 and 5,643,653 issued to Griesbach et al. which are incorporated by reference herein. The SMIC fabric that is formed can be positioned on a surface that includes topographical features and bonded with hot air to provide a SMIC fabric that includes surface features.

When used to make liquid absorbent articles, a nonwoven fabric of the present invention may be treated with conventional surface treatments or contain conventional polymer additives to enhance the wettability of the fabric. For example, the nonwoven fabric may be treated with polyalkylene-oxide modified siloxanes and silanes such as polyalkylene-oxide modified polydimethyl-siloxane as disclosed in U.S. Patent No. 5,057,361. Such a surface treatment enhances the wettability of the fabric. The nonwoven web may be treated before it is incorporated into a product.

Nonwoven fabrics of the present invention may include nonwoven fabrics having zones of different liquid handling properties. More specifically, a nonwoven fabric of the present invention may include a fabric that directs flow along all three dimensions of the fabric: along the length of the fabric coplanar with the land areas, along the width of the fabric coplanar with the land areas, and through the thickness or depth of the fabric. These zones of different liquid handling ability are created by areas of topographical surface definition. These topographical regions can vary in basis weight, density and/or filament orientation. In addition, the topographical features can have phobicity differences, which further enhance fluid handling.

As previously stated, nonwoven fabrics of the present invention can be used as separation layers or body side liner materials and may include materials having one large projection or a relatively small number of spaced projections. The present invention includes a nonwoven structure having macroscopic surface features that can be used to separate one surface from another surface, for example, a baby's bottom from an absorbent layer of a diaper. In several desirable embodiments, the structure has physical, aesthetic, and functional attributes that are particularly desirable for use as a body-side liner; a surge material or a liner/surge combination in disposable absorbent products such as: diapers; training pants; incontinent pads; feminine hygiene products such as feminine pads, sanitary napkins, and pantiliners; and so forth.

The discussion that follows is primarily directed to the use of the invention as a unique moisture-pervious top-sheet structure **100** embodied in a disposable diaper **400** as illustrate in Figures 7 and 8. While this is contemplated as being one desirable use, it should be understood that the present invention also has utility in a wide variety of absorptive devices, both disposable and reusable, such as sanitary napkins, catamenial tampons, incontinent pads, and so forth and in non-absorptive devices, such as industrial materials, sound proofing, insulation, packaging and so forth. The detailed description of the top-sheet structure **700** and its use in a disposable diaper **400** will allow those skilled in the art to readily adapt the invention to other devices.

As previously stated, it is desirable that the surface features of a web of the present invention are resistant to compression so that the web can be used as a body-side liner in a diaper or other absorbent product to separate the absorbent portion of the absorbent product from the wearer's skin. A view of a disposable absorbent product, for example a diaper **400**, is provided in Figure 6. Various layers have been cut away to more clearly show the structural details of this particular embodiment. A novel topsheet or body-side liner of the present invention is shown at **700**. The other two major components of the disposable diaper **400** are an absorbent element or pad **410** and a backsheet **430**. The drawing of diaper **400** in Figure 6 is a simplified representation of a disposable diaper. A more detailed description of a disposable diaper is contained in U.S. Patent no. 5,827,259 issued to Laux et al. and is hereby incorporated herein by reference.

Figure 7 illustrates a cross-sectional view taken through line 7-7 of Figure 6. The surface features **720** separate a wearer's skin **450** from absorbent material **410** located beneath the liner **700**. The liner **420** rests on the absorbent material **410** at base areas **702**. Desirably, the contact area of the surface features is less than the contact area of the base areas. Specifically, it is desirable that the nonwoven web **700** is oriented with the macroscopic surface features **720** that provide the least contact area under load are pointing toward the wearer **450**. It is also desirable that the contact area of a wearer with the liner is less than 50 percent of the surface area or footprint of wearer on the liner, more desirably the contact area is less than 40 percent, 30 percent and even more desirably the contact area is less than 25 percent. It is believed that reduction in contact between the wearer's skin and wet or damp portions of a diaper improves the skin health of the wearer. It is also believed that separation will improve fluid handling of an absorbent article.

It is not necessary that the surface features are completely resistant to compression. The surface features may compress when a compressive force is applied to the

topography. For example, when a baby sits down a majority of the baby's weight is transmitted to the surface features and the liner surface and the features may substantially compress providing little separation between the liner surface and the wearer's skin. However, it is desirable that the topography is not completely compressed during normal use and that some degree of separation is provided by the topography. It is also desirable that the surface features are resilient and are not permanently deformed by forces likely to be transmitted to the surface features during normal use. Specifically, it is desirable that deformation is within the elastic limits of the surface features and the accompanying structure. Thus, a wearer's skin is separated from a substantial portion of the liner surface by the surface features during use. The surface features should provide some degree of separation when a baby is at rest, crawling or walking and desirably even when a majority of the baby's weight is transmitted to the surface features or to the liner.

Although the nonwoven fabric webs of the exemplary embodiments were made by embossing spunbond webs, nonwoven webs of the present invention can be made through the use of other methods. Those of skill in the art will appreciate that a nonwoven web of the present invention can be made via other methods of making webs other than spunbond methods and by methods other than embossing. For example, a nonwoven web having surface macroscopic surface features can be made by the methods described in U.S. Patent Application Serial No. 10/136,702, entitled "METHODS FOR MAKING NONWOVEN MATERIALS ON A SURFACE HAVING SURFACE FEATURES AND NONWOVEN MATERIALS HAVING SURFACE FEATURES" filed by Express Mail Procedure **EL471213680 US** contemporaneously herewith and which is hereby incorporated by reference herein. Again, other processes of making nonwoven webs can be adapted to make webs that include surface features within the present invention. For example the nonwoven web may be a bonded-carded web (BCW), a coform web, an airlaid web, a spunbond/meltblown/spunbond (SMS) web and so forth. Additionally, the webs can be formed from or include a variety of materials, cellulose, pulp fibers, bicomponent fibers, and so forth. Other modifications and treatments known to those of skill in the art may be used with the present invention.

Nonwoven fabrics having stabilized three-dimensional, macroscopic topographical features can be produced by thermoforming flat non-woven base sheets. The nonwoven base sheet may be a bonded-carded web (BCW), a coform web, an airlaid web, a spunbond/meltblown/spunbond (SMS) web and so forth. Desirably, the webs are thermoformed to have surface features over less than 50 percent of the area of the web, more desirably, less than 40 percent, still more desirably less than 30 percent and most desirably less than 25 percent. It is also desirable that the material and basis weight of

the web and the pattern that is thermoformed are selected so that the features do not completely compress and provide separation at a pressure on the feature (P_f) of 1.2 kPa, more desirably do not completely compress and provide separation at 1.8 kPa and even at 10kPa. It is also desirable that the surface features that are thermoformed are at least 1 mm in height to provide increase separation and air circulation between the majority of the nonwoven material surface and a body that is in contact with the nonwoven material surface. It may be further desirable to provide surface features that are at least 1.5 mm, 3 mm, 5mm, and even 6 mm in height.

A nonwoven base sheet may be thermoformed to include macroscopic features on a heated surface, for example mating plates having surface features on a heated press, having macroscopic features. Heated presses are well known in the art and are readily available. The press should be set at a temperature high enough that to allow the nonwoven web to be permanently deformed but not so high so as to destroy the desirable properties of the nonwoven, for example breathability. Forming plates may have any of a variety of features to impart surface features to the nonwoven. A first pattern of surface features is illustrated in Figures 3A, 3B, and 3C and a second pattern of surface features is illustrated in Figures 4A and 4B. Each set of plates includes a first plate and a second plate having an array of surface features, for example squares or triangles, respectively. A variety of other patterns are possible, for example hexagons and diamonds, provided that one or more of the features are macroscopic. Two basic plate designs may be used for forming these plates, standard male and female plates or interdigitated plates. In the examples described herein interdigitating plates were used to provide repeating patterns of squares and triangles. The nonwoven base sheet is placed between the plates and heat and pressure are applied to thermoform the nonwoven base sheet. Three-dimensional nonwoven sheets having stabilized macroscopic topography were produced in the Examples. Although the illustrated nonwoven fabrics include surface features that are uniformly distributed in both the x-direction and the y-direction, nonwoven fabrics of the invention may include features that are uniformly distributed in only one direction. Furthermore, nonwoven fabrics of the invention may include features that are not uniformly provided or distributed on the fabric surface and can be provided and distributed in any pattern.

Nonwoven webs of the present invention that include macroscopic surface features may be treated with optional treatments and/or additives to modify one or more properties of the web. For example, non-raised areas of the webs may be treated with a hydrophilic treatment to increase fluid intake. The resulting non-treated raised areas, i.e. the surface features, will be more hydrophobic relative to the treated non-raised areas. Thus, this

web provides drier, raised surface contact areas and improving overall skin dryness. The surface features can run the entire length or width of a structure. The surface features can vary in rigidity to increase or decrease the weight-bearing capacity of the features and the nonwoven web.

In order to provide a better understanding of some features of nonwoven webs of the present invention, and not by way of limitation, the following examples and data are provided.

COMPARATIVE EXAMPLE A

A diaper liner material was used as a comparative example, Comparative Example A. Comparative Example A was a 0.5 osy nonwoven synthetic fabric web formed 98 percent by weight of 3155 polypropylene from Exxon of Houston, Texas and 2 percent by weight of titanium dioxide. The 0.5 osy nonwoven synthetic fabric web was formed by a spunbonded process. Fibers having a round cross section were used to form the web and had an average diameter of the approximately 22 microns (3 dpf). The web was formed by randomly laying continuous filaments and then thermal point bonding the randomly laid filaments. The thermal point bonding of the web was accomplished with a pattern having a bond area of 14-21 percent and a pin density of 460 pins/in^2. The pin geometry was a diamond geometry. Additional details of the liner material can be found in U.S. Patent No. 6,152,904 hereby incorporated by reference herein.

EXAMPLE 1

A nonwoven synthetic fabric web having macroscopic surface features was prepared by first forming an underbonded, bicomponent spunbond web and then embossing macroscopic features into the underbonded web. The macroscopic surface features were embossed into the web using heat and pressure applied by heated plates, with one of the plates having at least one macroscopic feature, to impart permanently deformed macroscopic projections into the web.

The underbonded, bicomponent spunbond nonwoven fabric web was formed from continuous bicomponent filaments. Continuous bicomponent filaments were made from approximately equal amounts of two polymer components in a side-by-side configuration. The composition of the first polymer component was 98 percent by weight of 3155 polypropylene from Exxon of Houston, Texas and 2 percent by weight of titanium dioxide. The composition of second component was 100 percent by weight of 61800 polyethylene from Dow Chemical Company of Midland, Michigan. The spin hole geometry of the spin pack was 0.6 mm diameter with a length to diameter (L/D) ratio of 4:1 and the spinneret

had 50 holes per inch (19.685 holes per cm) in the cross direction. The melt temperature in the spin pack was 410°F (210°C) and the throughput was 0.6 grams/hole/minute (ghm). The forming height was 12 inches (30.5cm). The quench air flow rate of the air quencher was 32 standard cubic feet per minute (scfm) and the temperature was 50°F (10°C). The aspirator temperature was ambient, approximately 75°F (23.9°C), and the aspirator pressure was 3.5 pounds per square inch (psi) (24.31kPa). An under wire vacuum at 7 inches water (17,440 dynes/cm^2) was used to collect the filaments onto a forming wire. A hot air knife (HAK) at 270°F (132.2°C) inlet air with an exit air temperature of 180°F (82.2°C), pressure was 0.8 psi (5.52kPa) and the height of the HAK above the wire was 1.5 inches (3.8 cm) was used to help integrate the filaments into an underbonded web. The unbonded nonwoven was then directed to a Through Air Bonder (TAB). The TAB was set at an air temperature of approximately 270°F (132.2°C) and 0.5 psi (34,470 dynes/cm^2) of air pressure and exhaust to form the fibers into an underbonded but integrated web. The line speed was adjusted to approximately 290ft/min. (88.5 m/min.) to produce a 0.5 ounces per yard (osy) [17 grams per square meter (gsm)] nonwoven material.

This underbonded web was then thermoformed into a three-dimensional nonwoven sheet having stabilized macroscopic topography by embossing a three-dimensional "squares" pattern into the web using heat and pressure applied by the heated interdigitating plates **300** and **350** illustrated in Figures 3A and 3B. Each interdigitating plate included a pattern of projections that intemeshed with a similar pattern of projections on the opposing plate. The first plate **300** included a checkerboard pattern of square projections as shown in Figure 3A. Each projection **310** on the first plate was approximately 3 millimeters in height and measured approximately 5 millimeters by 5 millimeters at the base and terminated in a square distal top surface **320** that measured slightly greater than 3 millimeters by 3 millimeters (approximately 3.5 mm x 3.5 mm). The projections were spaced apart approximately 9.5 millimeters from center to center in both x and y directions. The second plate **350** illustrated in Figure 3B included a similar pattern of alternating square projections **310** of approximately 4 millimeters in height, with each projection **310** measuring approximately 4 millimeters by 4 millimeters at the base and terminating in square distal top surface **320** that measured slightly less than 3 millimeters by 3 millimeters (approximately 2.9 mm x 2.9 mm).

The patterned plates were heated to a temperature of about 275 °F (135 °C) and the underbonded web was placed on one of the heated plated. The opposing heated plate was then placed on over the web so that the projections on the second plate intermeshed

with the projections on the first plate as illustrated in Figure 3C. Embossing pressure of approximately 115 psi (793 kPa) was then applied to the plates for approximately 35 seconds. After sufficient heat and pressure were applied to deform the web, the plates were separated and the web was removed from the between plates. The resulting three-dimensional material having macroscopic features is illustrated in Figures 1A, 1B and 1C and had an effective bulk thickness of 76 mils (1.93mm). The method of determining the effective bulk thickness employed a STARRET®-type bulk tester and a pressure (P_w) of 0.05 pounds per square inch (3,450 dynes/cm^2).

EXAMPLE 2

Example 1 was repeated except the line speed of the forming wire and TAB was adjusted to approximately 120ft/min. (36.6 m/min.) to produce a 1.2 ounces per yard (osy) [40.7 grams per square meter (gsm)] material. The 1.2 osy underbonded material of Example 2 was thermoformed using the squares pattern as described in Example 1. The resulting three-dimensional material having macroscopic features is illustrated in Figures 1A, 1B and 1C and had an effective bulk thickness of 80 mils (2.0 mm).

EXAMPLE 3

Example 1 was repeated except the line speed of the forming wire and TAB was adjusted to approximately 58ft/min. (17.7 m/min.) to produce a 2.5 ounces per yard (osy) [85 grams per square meter (gsm)] material. The 2.5 osy underbonded material of Example 3 was thermoformed using the squares pattern as described in Example 1. The resulting three-dimensional material having macroscopic features is illustrated in Figures 1A, 1B and 1C and had an effective bulk thickness of 98 mils (2.5 mm).

EXAMPLE 4

Example 2 was repeated except that a 1.2 osy underbonded web was thermoformed into a three-dimensional nonwoven sheet having stabilized macroscopic topography by embossing a three-dimensional "triangles" pattern into the web using heat and pressure applied by the heated interdigitating plates **400** and **450** illustrated in Figures 4A and 4B.

The 1.2 osy (40.7 gsm) underbonded web was thermoformed into a three-dimensional nonwoven sheet having stabilized macroscopic topography by embossing a three-dimensional "triangles" pattern into the web using heat and pressure applied by the heated interdigitating plates **400** and **450** illustrated in Figures 4A and 4B. Each interdigitating plate included a pattern of triangular projections that intermeshed with a

similar pattern of triangular projections on the opposing plate. The first plate **400** included a pattern of triangular tooth-like projections as shown in Figure 4A. Each triangular projection **410** on the first plate was approximately 3 millimeters in height and had an equilateral triangular base that measured approximately 8 millimeters along any one side and terminated in a equilateral triangular distal top surface **420** that measured approximately 5 millimeters along any one side. The projections were spaced apart approximately 9 millimeters from center to center in both x and y directions. The second plate **450** illustrated in Figure 4B included a similar pattern of alternating triangular projections **410** of approximately 4 millimeters in height, with each projection **410** having an equilateral triangular base measuring approximately 8.5 millimeters along any one side and terminating in equilateral triangular distal top surface **420** that measured approximately 5 millimeters along any one side.

The resulting three-dimensional material having macroscopic features is illustrated in Figures 5A, 5B and 5C and had an effective bulk thickness of 120 mils (3.05 mm).

EXAMPLE 5

Example 3 was repeated except that a 2.5 osy (85gsm) underbonded web was thermoformed into a three-dimensional nonwoven sheet having stabilized macroscopic topography by embossing a three-dimensional "triangles" pattern into the web using heat and pressure applied by the heated interdigitating plates **400** and **450** illustrated in Figures 4A and 4B. The resulting three-dimensional material having macroscopic features is illustrated in Figures 5A, 5B and 5C and had an effective bulk thickness of 133 mils (3.38 mm).

TEST METHODS

BASIS WEIGHT

Basis weights of the examples were determined by measuring and cutting 3 inch (7.6 cm) diameter circular samples from each sample of material. Each three-inch sample was weighed using a balance. The weight of a sample was recorded in grams and then divided by the sample area to provide the basis weight of the sample. Five samples of each example of material were measured and weighed using this procedure to provide an averaged basis weight for each example of nonwoven material.

CALIPER

Material caliper or thickness of the examples was also measured. The caliper of an example material was determined by measuring the thickness of the example material (web) under a 0.05 psi (3,450 dynes/cm^2) load (P_w) using a STARRET®-type bulk tester. The thicknesses were measured and recorded in units of millimeters. Samples of material were cut into 4 inch by 4 inch (10.2 cm by 10.2 cm) squares. Five samples were cut and measured under using the above-described procedure and averaged to provide a mean thickness for each example.

BULK DENSITY

The bulk densities of the nonwoven materials of the Examples were calculated by dividing the weight per unit area of a sample of the nonwoven material in grams per square meter (gsm) by the caliper of the sample of material in millimeters (mm). The web caliper was measured at 0.05 psi (3,450 dynes/cm^2) as described in determining caliper. The result was multiplied by 0.001 to convert the value to grams per cubic centimeter (g/cc). A total of five samples of each Example was evaluated and averaged to provide the density value.

CONTACT AREA

The contact surface areas of the nonwoven materials of the Examples were also measured. The test equipment included: a 3" x 4" (7.6cm x 10.2cm) sample stage with minimum thickness of ¼" inch (6.35mm), a 12.25" x 5" x 3/16" (31cm x 12.7cm x .48cm) piece of LUCITE®, a sample of each material cut into 3" x 4" (7.6cm x 10.2cm) rectangle, a bulk compressometer, a thermometer, a fine pen, transparency paper cut to a 3" x 4" (7.6cm x 10.2cm) rectangle, and an rH gauge (hygrometer). All contact areas that were measured using this procedure are nominal contact areas. That is the contact areas are defined by the contact that the surface features have with a flat surface resting on the features. This is not the sum of the individual fiber areas that are technically in contact with the flat surface over the projected area of the sample but include the areas between the individual fibers.

<u>Initial measurement and Setup</u>

1) Perform test in a controlled environment of 74 ±4 °F (23.3 ±2.2 °C) and 50 +/-10 % rH.

2) Samples shall be prepared from materials that are representative of materials produced as they are removed from the forming line and before they are wound or packaged.
3) Samples are to be cut from sections of the web that are uniform and representative of the parent material.
4) Three 3" X 4" (7.6cm x 10.2cm) rectangular samples are cut from the parent material of each Example.
5) The initial bulk of each sample is measured using a bulk compressometer.
6) A load is applied and when the reading is stable for 4 seconds the value is recorded. The sample is immediately removed from the load after the value is recorded.

<u>Initial Contact Surface / Area</u>

7) The 3" X 4" (7.6cm x 10.2cm) sample stage is placed on top of a flat, level surface.
8) The 3" X 4" (7.6cm x 10.2cm) sample is then lined with the stage and placed on top.
9) An initial surface contact area is taken by placing a flat, clear surface over the top of the sample. A piece of transparency paper was used for this method.
10) The material provides a load of less than 0.003 psi on the material for the initial reading.
11) From the perspective directly above each contacting topographic surface feature, the perimeter of surface contact is recorded for the materials by tracing the perimeter with a fine pen..
12) The area of the material contacting the flat surface is then recorded as the initial contact area. This area is determined from the tracing performed in step 11.
13) This initial contact area is divided by the projected area of the sample (i.e. 12 square inches) to give a percentage of contact surface / area for the sample.

<u>Contact Surface under Increased Load</u>

14) For additional contact area measurements under heavier loads, a flat rectangular piece of Lucite® material is placed over the sample material.
15) The center of the rectangular piece of Lucite® material is measured.
16) A 3" x 4" (7.6cm x 10.2cm) rectangle has been centered on the rectangular piece of Lucite® material and traced. The edges of the traced perimeter are parallel to the edges of the Lucite® material rectangle.

17) The Lucite® material is 12.25" x 5" x 3/16" (31cm x 12.7cm x .48cm) in dimension and weighs 0.6lbs (273 grams).

18) A piece of transparency paper is placed over the Lucite material so that the perimeter of the features may be recorded on the paper.

19) From the perspective directly above each contacting topographic surface feature, the perimeter of surface contact is recorded using a fine pen for the materials.

20) The area of the material contacting the flat surface is then recorded for the material and the load condition is also recorded.

21) This contact area under load is divided by the projected area of the sample (i.e. 12 $inch^2$ or $77.4cm^2$) to give a percentage of contact surface / area for the sample.

22) The average true load that the surface features experience is determined by dividing the weight the plate exerts on the sample by the area of the sample in contact with the flat load. E.g. 0.6lbs on a $12inch^2$ sample that has 20% contact area would show a 20% contact area at a pressure of 0.25 psi [0.6lbs / ($12inch^2 \times 20\%$)].

Additional contact area measurements were made using two different weights, 1.2lbs and 6 lbs (0.545 and 2.73 kg). The contact area is measured until the weight equaled 6lbs or the contact area is greater than 90 percent.

23) A flat rectangular piece of Lucite® material is placed over the sample material.

24) The center of the rectangular piece of Lucite® material is measured determined.

25) A 3" x 4" (7.6cm × 10.2cm) rectangle has been centered on the rectangular piece of Lucite® and traced. The edges of the traced perimeter are parallel to the edges of the Lucite® rectangle.

26) The Lucite® is 12.25" × 5" × 3/16" (31cm × 12.7cm × .48cm) in dimension and weighs 0.6lbs (273grams).

27) On the edges of the Lucite® material 0.3 lbs (136.35 grams) of weight are added on each end to provide a total weight of 1.2 lbs of force being placed on the 12 $inch^2$ web.

28) A piece of transparency paper is placed over the Lucite material so that the perimeter of the features may be recorded on the paper.

29) From the perspective directly above each contacting topographic surface feature, the perimeter of surface contact is recorded using a fine pen for the materials.

30) The area of the material contacting the flat surface is then recorded for the material and the load condition is also recorded.

31) This contact area under load is divided by the projected area of the sample (i.e. 12 $inch^2$) to give a percentage of contact surface / area for the sample.

32) The average true load that the surface features experience is determined by dividing the weight the plate exerts on the sample by the area of the sample in contact with the flat load. E.g. 6lbs on a $12inch^2$ sample that has 20% contact area would show a 20% contact area at a pressure of 2. 5 psi [$0.6lbs/(12inch^2 \times 20\%)$].

33) Repeat steps 22 -30 where step 26 is modified to provide a weight of 2.7 lbs (1227grams) on each side for a total load of 6lbs (2.72kg).

34) Perform experiment until either the total load on the sample equals 6lbs or the nominal contact area that the sample has with the flat material is greater than 90 percent.

35) Take and record the material's (web's) bulk at most 5 minutes after step 29.

PRESSURE APPLIED TO WEB (P_w)

Referring to Figure 2A, the contact area of object P with the nonwoven **100** is the sum of the cross-hatched areas shown in Figures 2A and 2C. The pressure that an object P supported by features **120** transmits to a nonwoven web **100** is measured by dividing the weight of the supported object P by the flat contiguous area that connects all of the points of the sheet that directly contact the article. For example, if an object is supported by sixteen macroscopic features **100**, then the area of the nonwoven web supporting the object P is the contiguous area ($W_p \times L_p$) measured in a plane parallel to the nonwoven base plane that connects all of the sixteen features or the parts of the sixteen features that support the object. In Figure 2C, the pressure that an object P supported by the nonwoven transmits to the sheet is measured by dividing the weight of the supported object P by the flat contiguous area L_p by W_p beneath the object.

AVERAGE PRESSURE OBSERVED BY SURFACE FEATURES (P_f)

The average true load that the surface features experience is determined by dividing the weight the plate exerts on the sample by the area of the sample in contact with the flat load. The average pressure observed by the surface feature P_f is determined by correcting for the actual area in contact with the load P_w. This is done by dividing P_w by the percent contact area.

WEB VOLUME MEASUREMENT METHOD

The nonwoven web volume is determined from a measurement of the void volume inside the web and the volume occupied by the fibers. Fiber volume is calculated from the weight of the web divided by fiber density. For webs that possess a high degree of topography, the internal void volume is measured from a liquid saturation experiment wherein liquid that is not contained in internal pores is excluded from the measurement.

This can be determined using an apparatus based on the porous plate method reported by Burgeni and Kapur in the *Textile Research Journal*, Volume 37, pp. 356-366 (1967), the disclosure of which is incorporated by reference. The apparatus includes a movable stage interfaced with a programmable stepper motor, and an electronic balance controlled by a computer. A control program automatically moves the stage to a desired height, collects data at a specified sampling rate until equilibrium is reached, and then moves the stage to the next calculated height. Controllable parameters include sampling rates, criteria for equilibrium and the number of absorption/desorption cycles.

Data for this analysis was collected using a liquid containing a surfactant to render the nonwoven web totally wettable and the measurement was done in desorption mode. That is, the material was saturated at zero height and the porous plate (and the effective capillary tension on the sample) was progressively raised in discrete steps corresponding to the desired capillary radius or capillary tension. At zero height, a certain amount of liquid trapped in the interface between the web and the plate exists, due to the topography of the nonwoven web. As the plate is raised, the amount of liquid pulled out from the sample was monitored. Readings at each height were taken every fifteen seconds and equilibrium was assumed to be reached when the average change of four consecutive readings was less than 0.005 g. The interfacial liquid (at the interface between the saturated nonwoven web sample and the porous plate) is typically removed by raising the plate slightly (0.5 – 0.7 cm). The internal void volume is expressed as cc/gram.

The nonwoven web volume is the sum of the internal void volume measurement described above and the fiber volume.

$$V_{nw} = \text{Web volume (cc/g)} = \text{Internal void volume} + (1/\text{fiber density})$$

VOLUME OF SPACE BETWEEN LINER AND A FLAT SURFACE AS MEASURED USING A BULK COMPRESSOMETER

A circular sample of each Example was taken and the volume the sample created by separating its top and bottom planes was determined by multiplying the area of the circle (3") and the sample's caliper t (t was determined using a STARRET®-type bulk

tester). This volume will be specified V_p to represent the volume of space separating the top and bottom planes of the shaped material.

$$V_p\ (cc) = t\ (cm) \times \text{area of circle}\ (cm_2)$$

The nonwoven web volume (V_{nw}) that was determined using the method described above was then be subtracted from volume of space separating the two planes (V_p) to yield the volume of space not occupied by the web between the two planes (V_s).

$$V_s\ (cc) = V_p\ (cc) - V_{nw}\ (cc)$$

Because V_{nw} and V_p were determined using the same circular sample area, the volume of space not occupied by the web between the two planes (V_s) can be divided by the area to determine volume (cc) / area(cm^2) or V_{sa}.

$$V_{sa}\ (cc / cm^2) = Vs\ (cc) / \text{area}\ (cm^2)$$

The materials used in the examples were generally symmetric. Therefore, the volume of space per unit area between the top surface of the liner and the skin V_{ls} was determined by dividing V_{sa} by 2.

$$V_{ls}\ (cc / cm^2) = V_{sa}\ (cc) / 2$$

This assumption is safe for the patterns used in the Examples because the surface that faces toward the body side provides the least amount of contact with the body. Therefore, assuming the sides are symmetric estimates the true volume above the web.

PERCENT RECOVERY

The method of determining bulk recovery uses P_w or the load that is observed by the web. The samples are cut into 3" circles, and the caliper or thickness of the samples is measured. The caliper of an example material is determined by measuring the thickness of the example material (web) under a 0.05 psi (3,450 dynes/cm^2) load (P_w) using a STARRET®-type bulk tester. The thickness is measured in units of thousandths of an inch. The recorded data provides an initial Bulk thickness ($Bulk_0$) for the material.

The sample is then removed and placed under a load P_w of 3.45 kPa. The load is applied for 5 minutes then removed. The material is allowed to recovery at ambient

conditions for 5 minutes. The caliper of the material is then measured once more using the bulk tester under the 0.05 psi (3,450 dynes/cm^2) load (P_w) to provide a final thickness ($Bulk_f$).

The final thickness is divided by the initial thickness to provide a percent recovery of the bulk.

$$\% \text{ Recovery} = Bulk_f / Bulk_0$$

TEST RESULTS

Test results of the tests on the Examples are provided in Table A below. Failure of a material to provide separation is indicated by the symbol " -- " in Table A.

Topographic Liner Properties										
Example	Pattern	Bulk Density (g/cc)	% CONTACT AREA UNDER SPECIFIED LOAD			V_{ts} (cc/cm^2)	% Recovery $bulk_f/bulk_0$	$Bulk_0$ (mils/ microns)	$Bulk_f$ (mils/ microns)	t (mils / microns)
A	Flat	0.067	--	--	--	0.000	100%	8 / 200	8 / 200	8 / 200
1	0.5 osy (17gsm) Squares	0.012	25% @0.2psi (1.4 kPa)	--	--	0.086	80%	76 / 1930	61 / 1550	10 / 250
2	1.2 osy (41gsm) Squares	0.018	30.2% @0.17psi (1.2 kPa)	37% @0.27psi (1.9 kPa)	--	0.087	95%	80 / 2030	76 / 1930	16 / 405
3	2.5 osy (85gsm) Squares	0.036	26% @0.19psi (1.3 kPa)	27% @.37psi (2.55 kPa)	27% @1.86psi (12.8 kPa)	0.096	98%	98 / 2490	96 / 2440	20 / 510
4	1.2 osy (41gsm) Triangles	0.014	23% @0.22psi (1.5 kPa)	37% @0.27psi (1.9 kPa)	--	0.120	94%	120 / 3050	113 / 2870	16 / 405
5	2.5 osy (85gsm) Triangles	0.025	20% @0.25psi (1.7 kPa)	20% @0.51psi (3.5 Kpa)	26% @1.91psi (13.2 kPa)	0.138	96%	133 / 3380	128 / 3250	20 / 510

Thus, it is apparent that there has been provided, in accordance with the invention, a nonwoven fabric having macroscopic surface features. While the invention has been described in conjunction with specific embodiments thereof, it is evident that many

alternatives, modifications, and variations will be apparent to those skilled in the art in light of the foregoing description. Accordingly, it is intended to embrace all such alternatives, modifications, and variations as fall within the spirit and broad scope of the appended claims.

We claim:

1. A three-dimensional nonwoven web having a regional, bulk density of less than 0.04 grams per cubic centimeter and comprising

   a top-side base surface that defines an x,y-plane and

   at least one macroscopic surface feature extending out of the x,y-plane wherein a macroscopic surface feature is characterized as a feature having an apex that extends at least about 1 millimeters above the x,y-plane of the top-side base surface and the maintains a height of at least 1 millimeter above the x,y-plane of the top-side base surface under a 1.2 kPa load (P_f)

   wherein the at least one macroscopic feature results in contact of an object resting on the macroscopic feature such that the percent contact area of the nonwoven web with an article resting on the macroscopic surface feature at a 1.2 kPa load (P_f) is less than 50 percent of the bulk area of the nonwoven web supporting the article.

2. The nonwoven web of Claim 1, wherein a macroscopic feature is characterized as a feature having an apex that extends at least 1.5 millimeters above the x,y-plane.

3. The nonwoven web of Claim 1, wherein a macroscopic feature is characterized as a feature having an apex that extends at least 3 millimeters above the x,y-plane.

4. The nonwoven web of Claim 1, wherein a macroscopic feature is characterized as a feature having an apex that extends at least 5 millimeters above the x,y-plane.

5. The nonwoven web of Claim 1, wherein a macroscopic feature is characterized as a feature having an apex that extends at least about 6 millimeters above the x,y-plane.

6. The nonwoven web of Claim 1, wherein the percent contact area of the nonwoven web with an article resting on the macroscopic surface feature at a 1.2 kPa load (P_f) is less than 40 percent of the bulk area of the nonwoven web supporting the article.

7. The nonwoven web of Claim 1, wherein the percent contact area of the nonwoven web with an article resting on the macroscopic surface feature at a 1.2 kPa load (P_f) is less than 30 percent of the bulk area of the nonwoven web supporting the article.

8. The nonwoven web of Claim 1, wherein the percent contact area of the nonwoven web with an article resting on the macroscopic surface feature at a 1.2 kPa load (P_f) is less than 25 percent of the bulk area of the nonwoven web supporting the article.

9. The nonwoven web of Claim 1, wherein the nonwoven web comprises a plurality of macroscopic features and the frequency of macroscopic features is at least 1 macroscopic surface feature per 100 square centimeters of nonwoven web in the in the x,y-plane.

10. The nonwoven web of Claim 1, wherein the nonwoven web comprises a plurality of macroscopic features and the frequency of macroscopic features is at least 1 macroscopic surface feature per 50 square centimeters of nonwoven web in the in the x,y-plane.

11. The nonwoven web of Claim 1, wherein the nonwoven web comprises a plurality of macroscopic features and the frequency of macroscopic features is at least 1 macroscopic surface feature per 10 square centimeters of nonwoven web in the in the x,y-plane.

12. The nonwoven web of Claim 1, wherein the nonwoven web comprises a plurality of macroscopic features and the frequency of macroscopic features is at least 1 macroscopic surface feature per 1 square centimeter of nonwoven web in the in the x,y-plane.

13. The nonwoven web of Claim 1, wherein the regional bulk density of the nonwoven web is less than 0.03 grams per cubic centimeter.

14. The nonwoven web of Claim 1, wherein the regional bulk density of the nonwoven web is less than 0.02 grams per cubic centimeter.

15. The nonwoven web of Claim 9, wherein the macroscopic features maintain a height of at least 1.5 millimeters above the x,y-plane of the top-side base surface under a 1.2 kPa load (P_f).

16. The nonwoven web of Claim 9, wherein the macroscopic features maintain a height of at least 3 millimeters above the x,y-plane of the top-side base surface under a 1.2 kPa load (P_f).

17. The nonwoven web of Claim 9, wherein the macroscopic features maintain a height of at least 6 millimeters above the x,y-plane of the top-side base surface under a 1.2 kPa load (P_f).

18. The nonwoven web of Claim 1, wherein the macroscopic feature maintains a height of at least 1 millimeter above the x,y-plane of the top-side base surface under a 1.8 kPa load (P_f).

19. The nonwoven web of Claim 1, wherein the macroscopic feature maintains a height of at least 1.5 millimeters above the x,y-plane of the top-side base surface under a 1.8 kPa load (P_f).

20. The nonwoven web of Claim 1, wherein the macroscopic feature maintains a height of at least 3 millimeters above the x,y-plane of the top-side base surface under a 1.8 kPa load (P_f).

21. The nonwoven web of Claim 1, wherein the macroscopic feature maintains a height of at least 6 millimeters above the x,y-plane of the top-side base surface under a 1.8 kPa load (P_f).

22. The nonwoven web of Claim 1, wherein the macroscopic feature maintains a height of at least 1 millimeter above the x,y-plane of the top-side base surface under a 10 kPa load (P_f).

23. The nonwoven web of Claim 1, wherein the macroscopic feature maintains a height of at least 1.5 millimeters above the x,y-plane of the top-side base surface under a 10 kPa load (P_f).

24. The nonwoven web of Claim 1, wherein the macroscopic feature maintains a height of at least 3 millimeters above the x,y-plane of the top-side base surface under a 10 kPa load (P_f).

25. The nonwoven web of Claim 1, wherein the macroscopic feature maintains a height of at least 6 millimeters above the x,y-plane of the top-side base surface under a 10 kPa load (P_f).

26. The nonwoven web of Claim 9, wherein the macroscopic features provide at least 0.08 cubic centimeters of air space between the top surface of the nonwoven web and an article resting on the macroscopic surface feature at a 1.2 kPa load (P_f) of article to contact area of nonwoven web per 1.0 square centimeter of nonwoven web.

27. The nonwoven web of Claim 9, wherein the macroscopic features provide at least 0.09 cubic centimeters of air space between the top surface of the nonwoven web and an article resting on the macroscopic surface feature at a 1.2 kPa load (P_f) of article to contact area of nonwoven web per 1.0 square centimeter of nonwoven web.

28. The nonwoven web of Claim 9, wherein the macroscopic features provide at least 0.10 cubic centimeters of air space between the top surface of the nonwoven web and an article resting on the macroscopic surface feature at a 1.2 kPa load (P_f) of article to contact area of nonwoven web per 1.0 square centimeter of nonwoven web.

29. The nonwoven web of Claim 1, wherein the nonwoven web has a uniform composition in the x and y directions.

30. The nonwoven web of Claim 1, wherein the nonwoven web comprises a laminate.

31. The nonwoven web of Claim 1, wherein the nonwoven web comprises bicomponent fibers.

32. A three-dimensional, nonwoven web having a regional, bulk density of less than 0.03 grams per cubic centimeter and comprising

a top-side base surface that defines an x,y-plane and

a plurality of macroscopic surface features extending out of the x,y-plane at a frequency of at least one macroscopic feature per 100 square centimeter of nonwoven web wherein a macroscopic surface feature is characterized as a feature having an apex that extends at least about 3 millimeters above the x,y-plane of the top-side base surface and the maintains a height of at least 3 millimeters above the x,y-plane of the top-side base surface under a 1.2 kPa load (P_f)

wherein the macroscopic features results in contact of an object resting on the macroscopic feature such that the percent contact area of the nonwoven web with an article resting on the macroscopic surface features at a 1.2 kPa load (P_f) less than 40 percent of the bulk area of the nonwoven web supporting the article.

33. The nonwoven web of Claim 32, wherein a macroscopic feature is characterized as a feature having an apex that extends at least 5 millimeters above the x,y-plane.

34. The nonwoven web of Claim 32, wherein a macroscopic feature is characterized as a feature having an apex that extends at least about 6 millimeters above the x,y-plane.

35. The nonwoven web of Claim 32, wherein the percent contact area of the nonwoven web with an article resting on the macroscopic surface feature at a 1.2 kPa load (P_f) is less than 30 percent of the bulk area of the nonwoven web supporting the article.

36. The nonwoven web of Claim 32, wherein the percent contact area of the nonwoven web with an article resting on the macroscopic surface feature at a 1.2 kPa load (P_f) is less than 25 percent of the bulk area of the nonwoven web supporting the article.

37. A three-dimensional, embossed nonwoven web having a regional, bulk density of less than 0.03 grams per cubic centimeter and comprising

a top-side base surface that defines an x,y-plane and

a plurality of macroscopic surface features extending out of the x,y-plane at a frequency of at least one macroscopic feature per 1 square centimeter of nonwoven web wherein a macroscopic surface feature is characterized as a feature having an apex that extends at least about 5 millimeters above the x,y-plane of the top-side base surface and the maintains a height of at least 3 millimeters above the x,y-plane of the top-side base surface under a 1.8 kPa load (P_f)

wherein the macroscopic features results in contact of an object resting on the macroscopic feature such that the percent contact area of the nonwoven web with an article resting on the macroscopic surface features at a 1.8 kPa load (P_f) is less than 40 percent of the bulk area of the nonwoven web supporting the article.

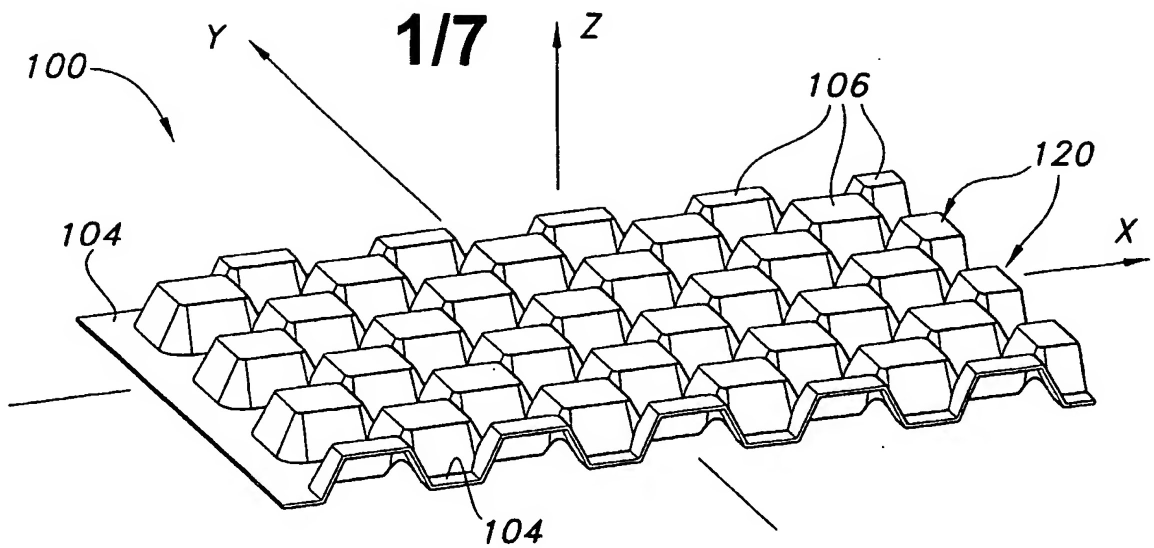

FIG. 1A

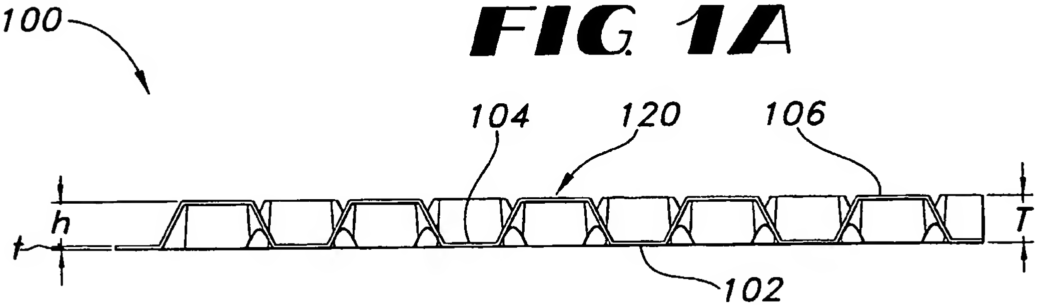

FIG. 1B

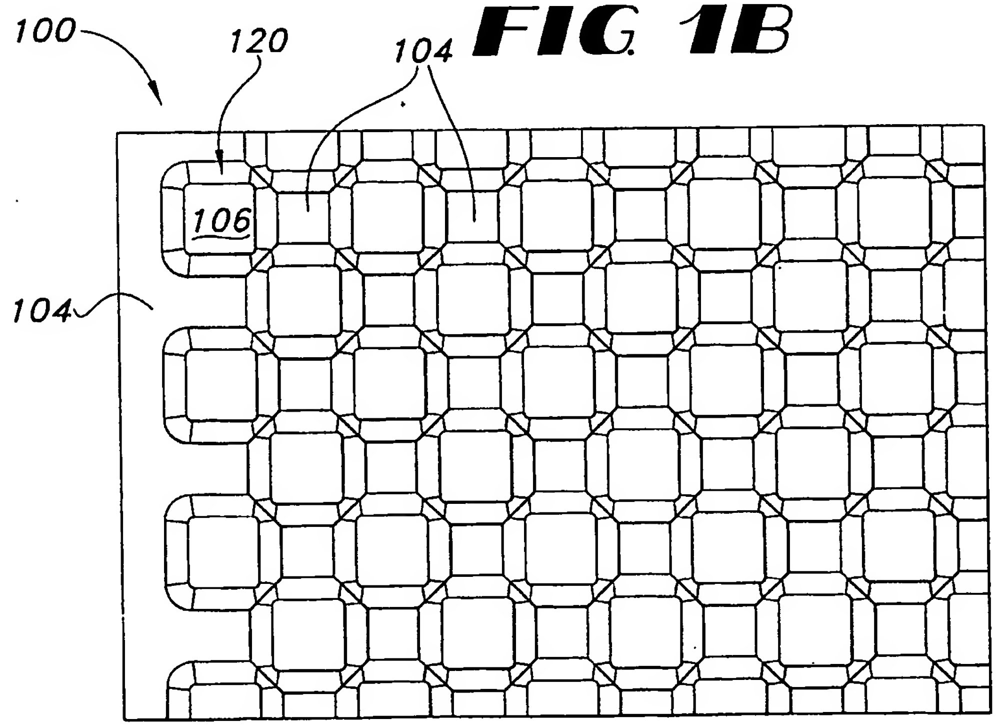

FIG. 1C

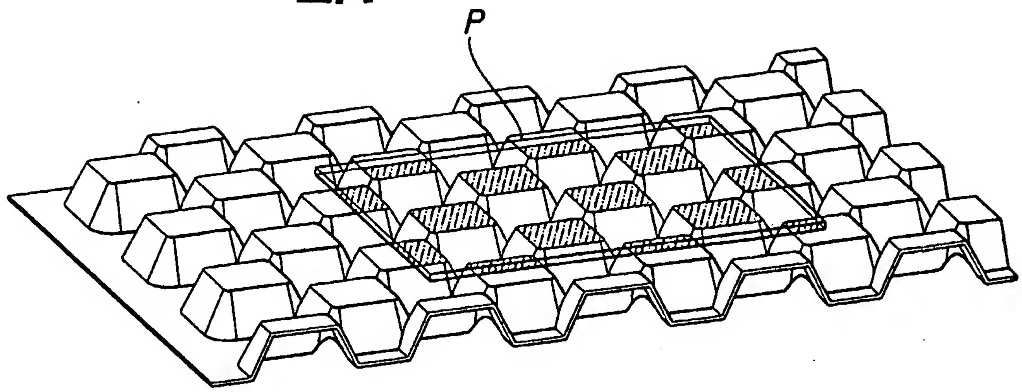

FIG. 2A

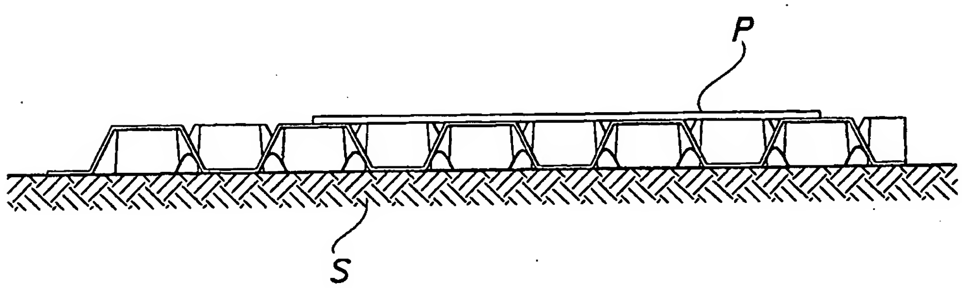

FIG. 2B

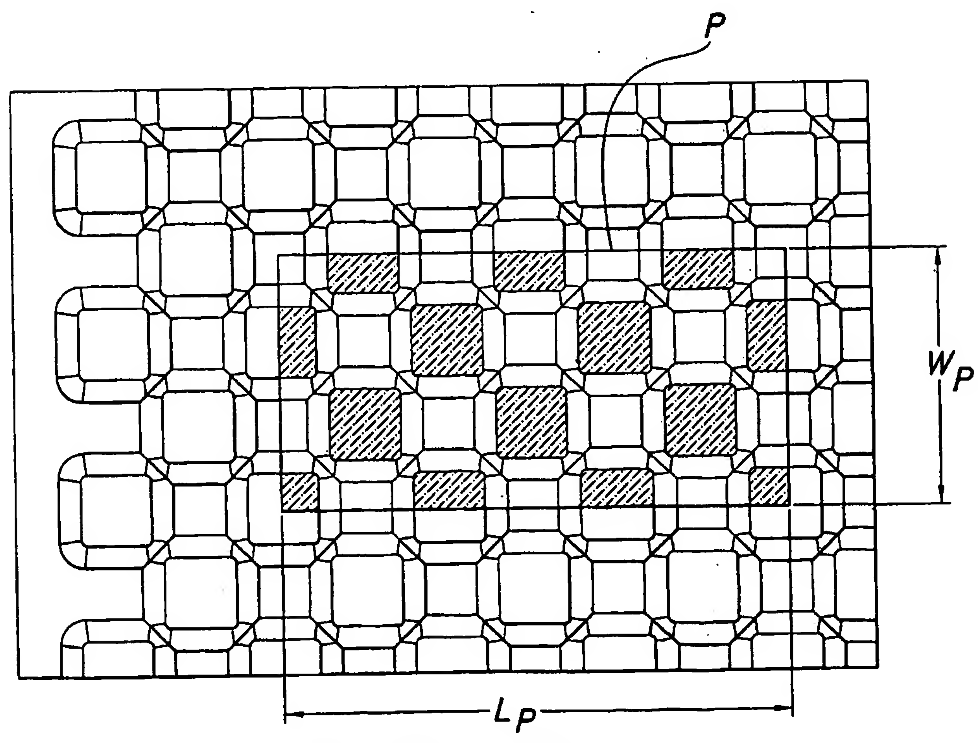

FIG. 2C

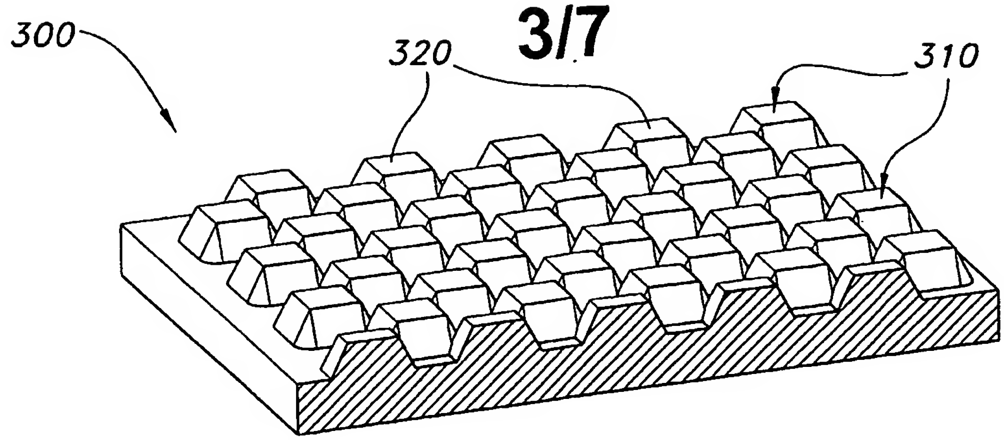

FIG. 3A

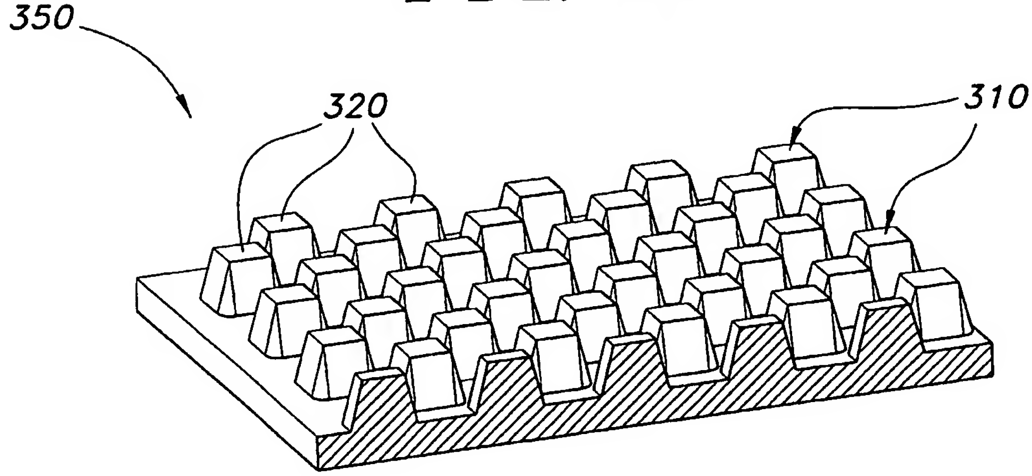

FIG. 3B

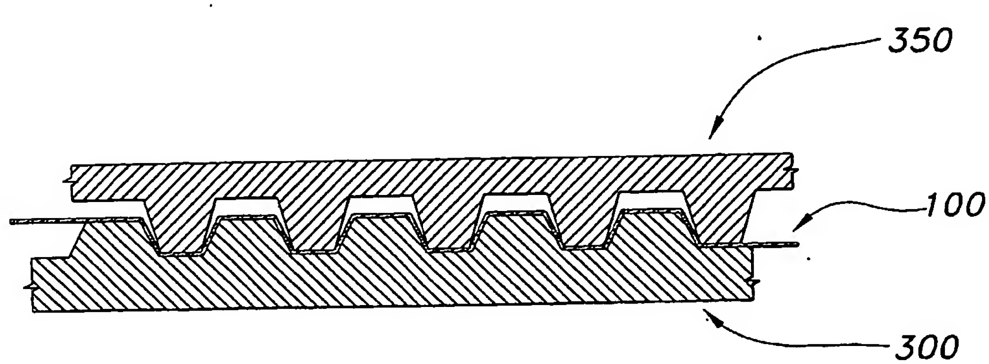

FIG. 3C

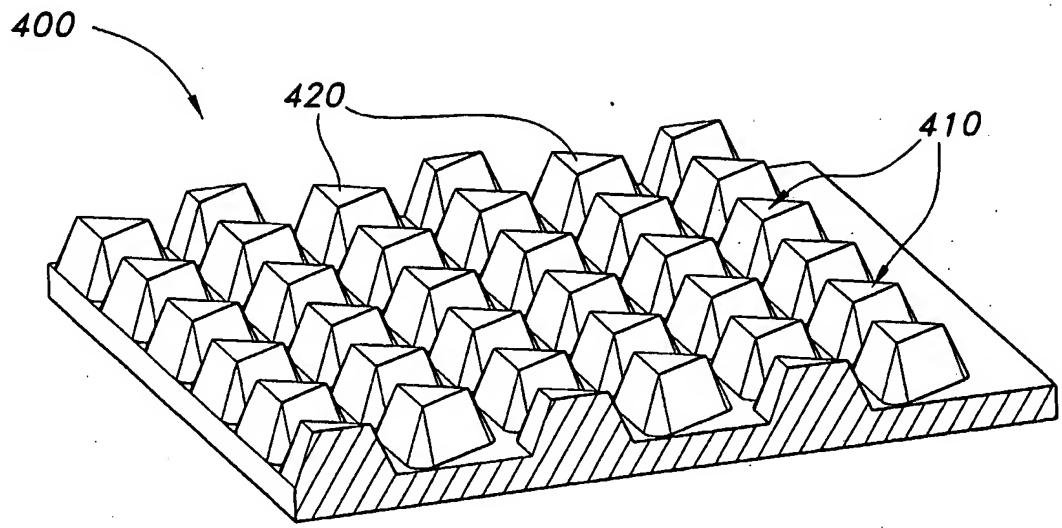

FIG. 4A

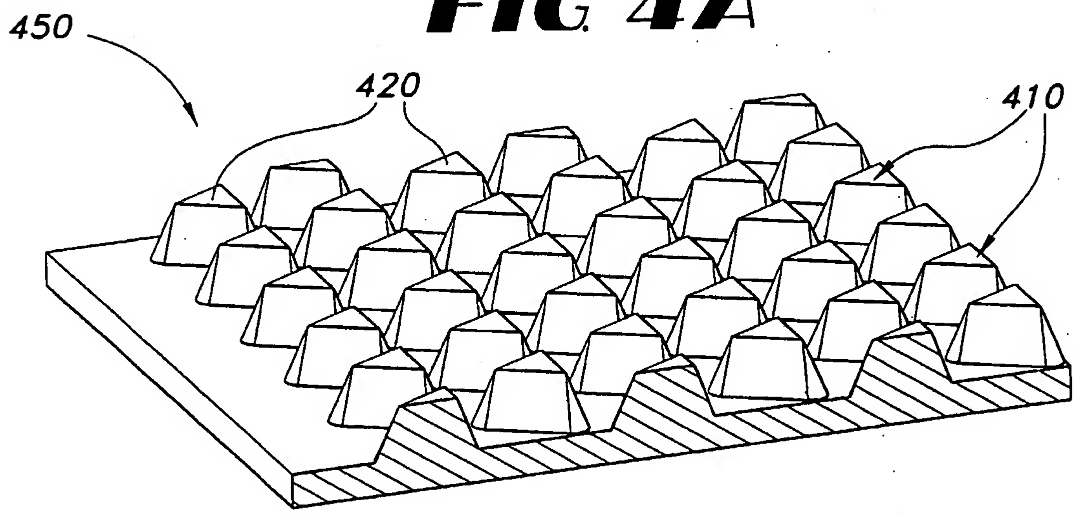

FIG. 4B

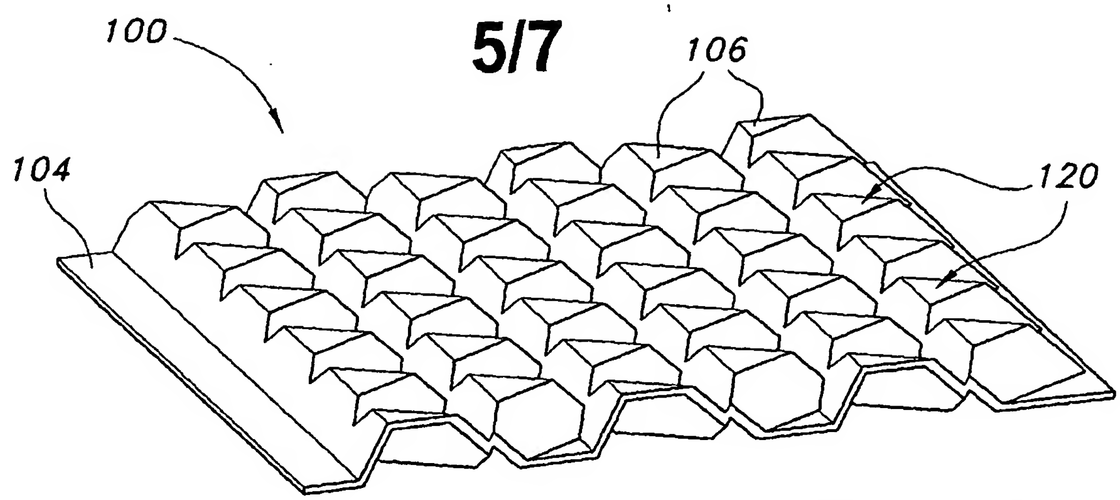

FIG. 5A

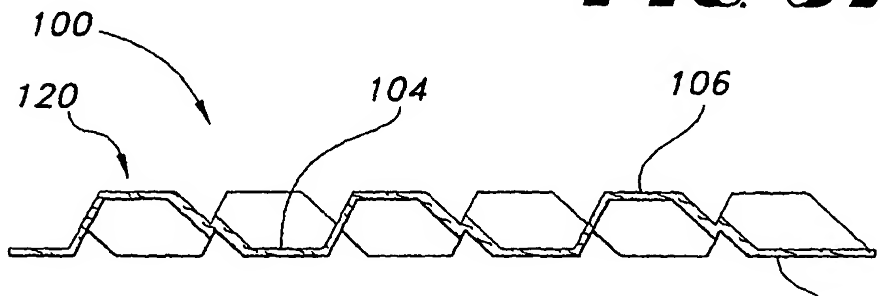

FIG. 5B

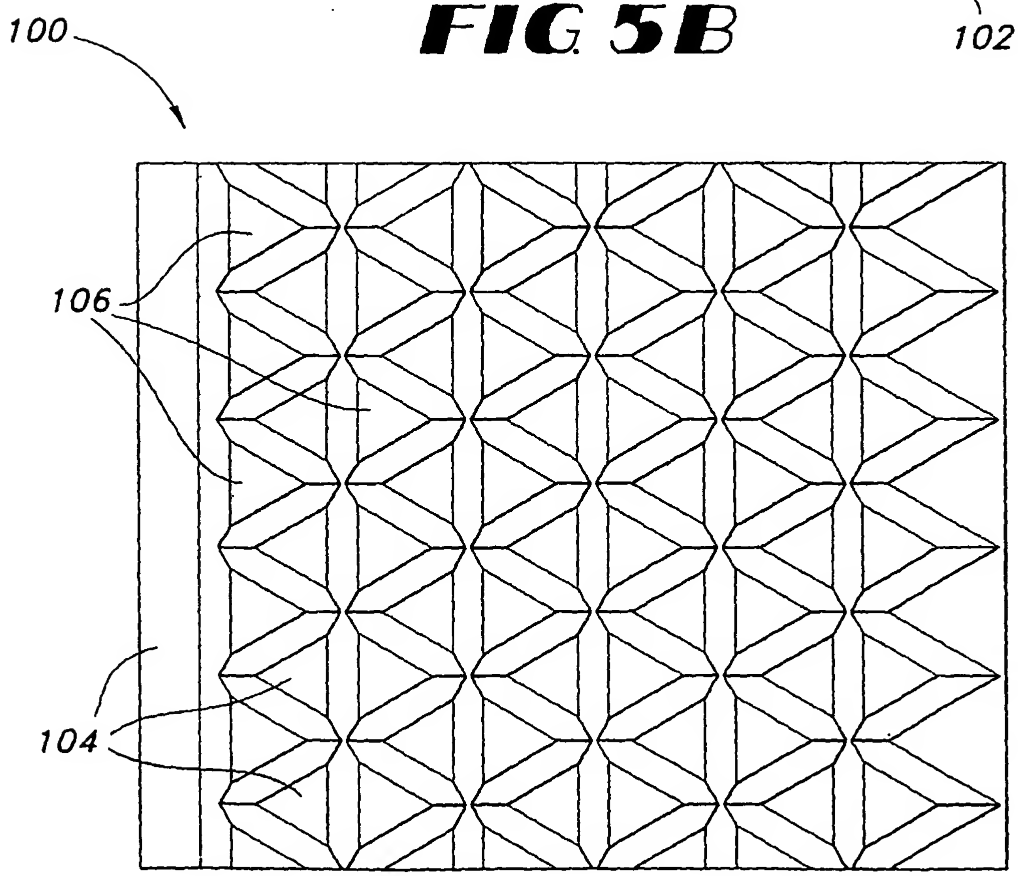

FIG. 5C

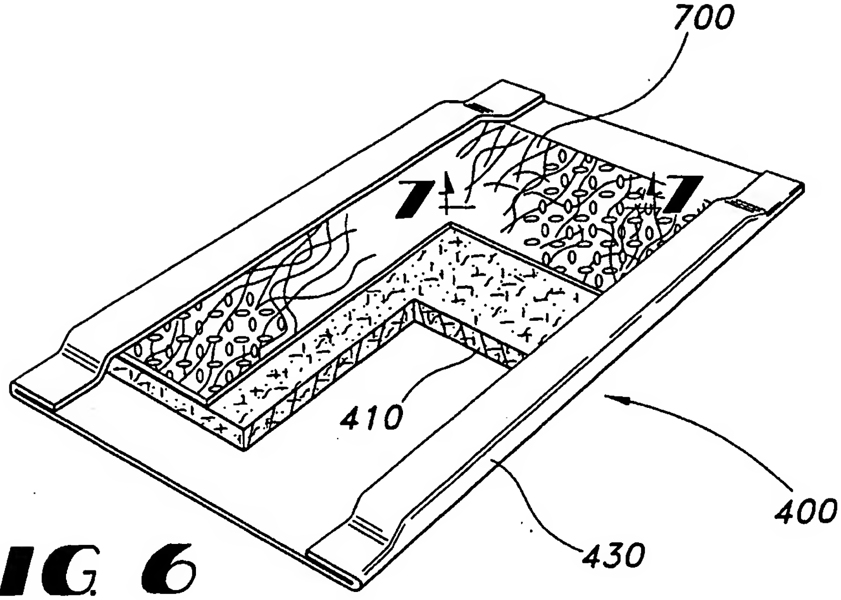

FIG. 6

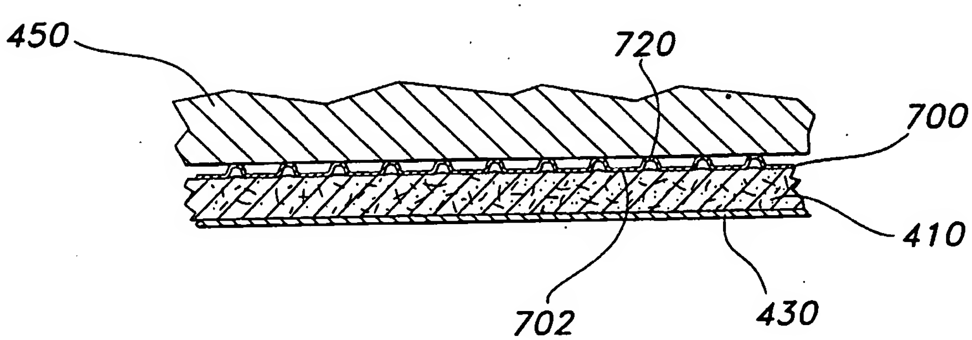

FIG. 7

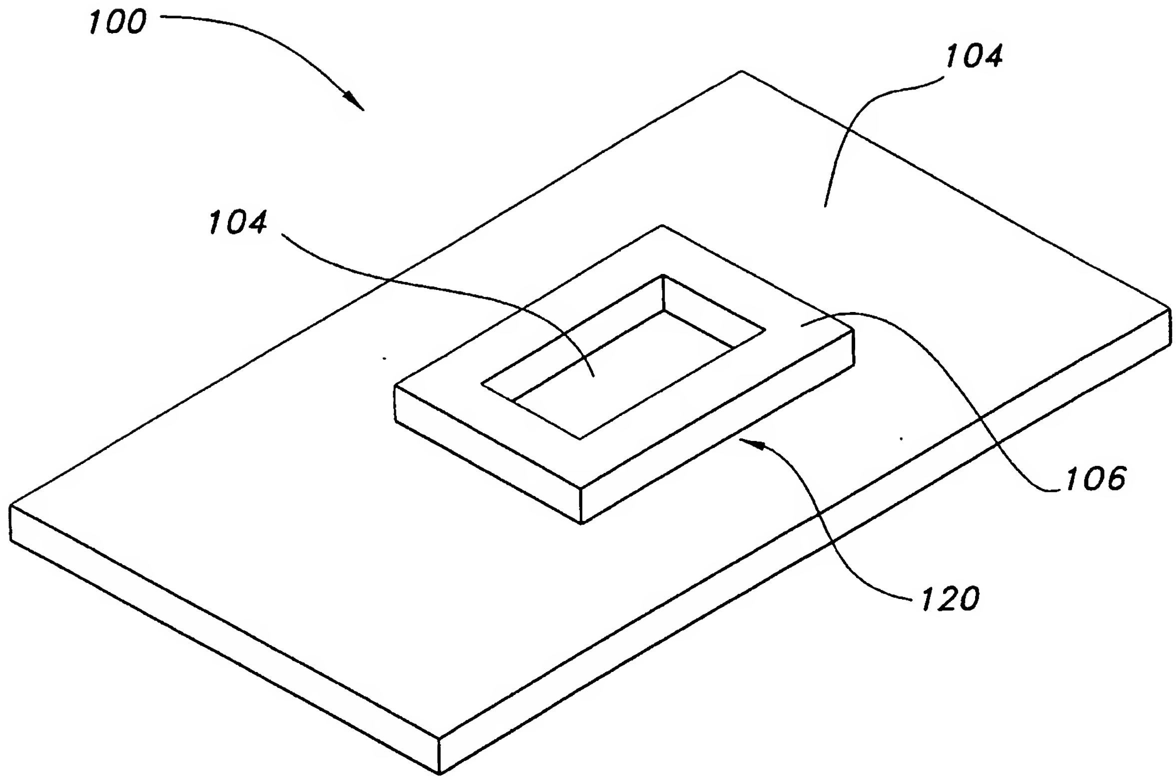

FIG. 8

INTERNATIONAL SEARCH REPORT

Interna[redacted] Application No
PCT/US 03/11747

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D04H3/16 D04H3/14 B29C59/02 B31F1/07

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 D04H B29C B31F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 15, 6 April 2001 (2001-04-06) & JP 2000 355866 A (CHISSO CORP), 26 December 2000 (2000-12-26) abstract	
A	-& JP 2000 355866 A (CHISSO CORP) 26 December 2000 (2000-12-26) the whole document -----	
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 11, 30 September 1998 (1998-09-30) & JP 10 158969 A (OJI PAPER CO LTD), 16 June 1998 (1998-06-16) abstract -/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 August 2003	14/08/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Barathe, R.

INTERNATIONAL SEARCH REPORT

Internat[redacted] Application No
PCT/US 03/11747

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	-& JP 10 158969 A (OJI PAPER CO LTD) 16 June 1998 (1998-06-16) the whole document -----	
A	WO 97 24916 A (HOECHST CELANESE CORP) 17 July 1997 (1997-07-17) cited in the application the whole document -----	
A	US 5 643 653 A (GRIESBACH III HENRY LOUIS ET AL) 1 July 1997 (1997-07-01) cited in the application the whole document -----	
A	US 5 575 874 A (GRIESBACH III HENRY L ET AL) 19 November 1996 (1996-11-19) cited in the application the whole document -----	
A	WO 98 58109 A (WAGNER WERNER ; HCD GMBH (DE)) 23 December 1998 (1998-12-23) the whole document -----	
A	US 3 616 157 A (SMITH J HAROLD) 26 October 1971 (1971-10-26) the whole document -----	

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 1-37

Present claims 1-37 relate to products defined (inter alia) by reference to the following parameters:

"At least one macroscopic surface feature extending out of the x,y-plane wherein a macroscopic surface feature is characterized as a feature having an apex that extends at least about 1 millimeter above the x,y- plane of the top-side base surface and the maintains a height of at least 1 millimeter above the x,y-plane of the top-side base surface under a 1.2 kPa load (Pf),
wherein the at least one macroscopic feature results in contact of an object resting on the macroscopic feature such that the percent contact area of the nonwoven web with an article resting on the macroscopic surface at a 1.2 kPa load (Pf) is less than 50 percent of the bulk area of the nonwoven web supporting the article."

The use of these parameters in the present context is considered to lead to a lack of clarity within the meaning of Article 6 PCT.
It is impossible to compare the parameters the applicant has chosen to employ with what is set out in the prior art. The lack of clarity is such as to render a meaningful complete search impossible. Consequently, the search has been restricted to:

the parts relating to the embodiments/compounds/products/methods mentioned in the exemples 1-5.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.5), should the problems which led to the Article 17(2) declaration be overcome.

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INTERNATIONAL SEARCH REPORT

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 1-37
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Interna[redacted] Application No
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